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СОВРЕМЕННЫЕ ПРОБЛЕМЫ ОКЕАНОГРАФИИ ОКРАИННЫХ МОРЕЙ АЗИИ

4-я конференция по Международной программе PEACE

17–19 сентября 2008 г., Владивосток, Россия

Тезисы докладов

CONTEMPORARY PROBLEMS OF THE EAST ASIAN SEAS OCENOGRAPHY

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Abstracts

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Рассматривается широкий круг вопросов физической, химической и биологической океанографии морей Восточной Азии, новые инструменты и средства сбора информации, включая спутниковые системы, буи и платформы.

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Problems of physical, chemical, and biological oceanography of the East Asian Seas, as well as new instruments and observation systems, including satellites, buoys, and platforms, are considered. The Workshop is held in POI FEB RAS, with the support of Research Institute of Applied Mechanics, Kyushu University, Japan, and of Far-Eastern Branch of Russian Academy of Sciences, Vladivostok, Russia.

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ТЕЗИСЫ ДОКЛАДОВ

A B S T R A C T S

THE ASSESSMENT OF PREDICTABILITY OF THE NORTH PACIFIC SEA TEMPERATURE USING A CGCM

Joong-Bae Ahn

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Based on the analysis of 29 cases of 12-month lead hindcasts using a CGCM, the predictability of the CGCM is assessed in terms of North Pacific sea temperature. The model used in this study is PNU/CME CGCM consisted of CCM3 AGCM, MOM3 OGCM and a plastic viscous sea ice model. No flux adjustment is applied in the experiment. In each hindcast, the prediction starts with the oceanic and atmospheric initial conditions of the first day of July of each year between 1979 and 2007 (29 years).

According to the hindcast experiments, the predictability is relatively high along the equatorial regions compared to the rest of North Pacific in terms of temporal correlation coefficient. In particular, the coefficients in Nino 3.4 region maintain over 0.6 throughout the 12-month lead integration. Also in the south of 40 °N, significantly high predictability persists considerable leading time. After 5th month of lead time (6 months later after coupling), however, the predictability over the north of 40 °N becomes very poor.

The regions of relatively low predictability are, in general, related to the locations of ocean polar front, narrow extent of currents such as North Equatorial Countercurrent and marginal area of sea-ice. This implies that the finer resolution is still necessary for the model to have higher predictability. Currently, the oceanic part of the CGCM has variable grid in the meridional direction of 0.968° in the equatorial region and 2.790° in the north of 50 °N.

CURRENT DISPERSION TENSOR ESTIMATED FROM ALTIMETRY DATA OF THE ERS-I, ERS-2, AND TOPEX/POSEIDON SATELLITES

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Variability of currents derived from altimetry sea level, is estimated using probabilistic characteristics, namely current dispersion tensor computed by quasi-geostrophic formulas from altimetry data of the ERS-I, ERS-2, and Topex/Poseidon satellites for 0.25° boxes in the area of 30-50°N, 140-160°E.

Linear invariant of current dispersion tensor is a measure of intensity of speed fluctuations. Generally, intensity does not exceed 110-120 cm^2/c^2, while it reaches 150-180 cm^2/c^2 within the Kuroshio and its northeast branch.

A large semi-axis of current dispersion tensor runs along the meridian. This is a convincing proof of prevalence of currents caused by gradient-vorticity waves. The ratio of small to large semi-axis of current dispersion tensor mostly does not exceed 0.1-0.2 but reaches 0.4-0.5 within the Kuroshio. Obviously, it is a result of significant power contribution in the Kuroshio flow give alongside with waves synoptic vortex and local atmospheric influence. The ratio of small to large semi-axis is rather small, as should be in quasi-geostrophic waves.

The vector-algebraic method (Belyshev, Rozhkov at el, 1983) was applied to estimate statistical characteristics of currents. For simplification of interpretation of results a test computation was carried out, with the analytical expression for level slopes as harmonic wave extending in the zonal direction with amplitude exponentially decreasing in the meridional direction.

For test estimation of the currents non-stationary geostrophic approximation is accepted by results of the test account a root-mean-square field of level deviation was investigated which has shown an expected invariance root-mean-square field of level deviation in a zone direction and its exponential attenuation in a meridional direction.

MORPHOLOGY EVOLUTION AND SUSPENDED MATTER HYDRODYNAMIC PROCESS OF MIN RIVER ESTUARY, CHINA

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3 survey stations of current and sand are implemented for 25 hours in Min River estuary, in the meantime, ADCP and CTD/turbidity are observed. Suspended sand transportation and hydrodynamic process are studied. Base on 5 time series navigation chart, estuary morphology evolution trend are defined. The main results are: 1) Suspended matter are transported to east out of the estuary firstly by tide current for about 20km, after that suspended matters are turn to south east. 2) North branch of river has stronger capacity of transporting suspended sand than south branch, and during observation time net sand transportation appears to land in south branch, the north branch acts as the main channel for discharging riverine matters. 3) Due to high current velocity, sea bed sediment are easy to be suspended in most of tide cycle, and the south branch has higher re-suspension capacity. 4) Due to construction of dams,

bridges, reclaiment and jetty in upstream, sand discharge has declined since 1950s, which makes estuary hydrodynamic condition change that the south branch began to be dominated by tide rather than by river, and the north branch is on the contrary. 5) The changes of hydrodynamic condition help to maintain navigation channel of the north branch, and stability of estuary wetland.

FOG FORMATION AFFECTED BY SYNOPTIC SCALE WIND AND SEA SURFACE TEMPERATURE DISTRIBUTION IN THE WESTERN COASTAL SEAS OF KOREA

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The generation of fog along the western coast of Korea under the influence of synoptic scale wind and sea surface temperature was investigated using a three-dimensional non-hydrostatic meteorological model-MM5, version 3.75 and GOES and NOAA satellite pictures from February 21 through 23, 2005. As an initial input data for MM5 model, global meteorological data set – NECP was adopted and meteorological elements such as wind, relative humidity and air temperature were evaluated on each 3 km, 9 km and 27 km of a horizontal grid interval in different model domains. As supplementary materials, QuickSCAT wind data was also used for analyzing marine wind in the Yellow Sea. The comparison of evaluated meteorological elements by the numerical model with observed ones was carried out at the coastal meteorological observation points established by Korea Meteorological Administration. On February 21, synoptic scale wind in the coastal sea of the western Korea and the Yellow sea was northwesterly with about 5m/s and on February 22, the wind was changed from northwesterly into southwesterly and was more intensified into 10m/s. Counterclockwise wind system could induce wind driven current to move toward southwest and southeast. Under this situation, the cool water was intruded from the northern part of the Yellow sea into southwest and southeast and the area of sea surface temperatures (SST) below 5°C was extended toward west and south, counterclockwise, especially showing the southern extension of area of SST below 5°C along the western coast of Korea. Under the influence of the cold water intrusion in the range of 2°C ~ 5°C, the area of below 5°C was extended to about 100 km away from the coast. For instance, SST in the coastal sea of Mokpo city on February 21 was 8°C and the SST decreased to 6°C. Since fog with relative humidity (RH) over 85% was found at 0300 LST, February 22 near the coastal sea of Inchon city, the area of fog formation was

extended along the coast toward south with time, until the next day morning of February 23. In general, RH should be 100% for the formation of fog in the inland, but RH greater than 85% is sufficient for the fog formation over the sea, as salt nuclei can act as cloud nuclei. In order to distinguish fog from cloud, RH was evaluated on 10m, 500m and 1km heights over the sea surface. Air temperature over the sea surface significantly reflected the variation of the SST distribution.

This work was funded by the Korea Meteorological Administration Research and Development Program under Grant CATER 2006-2308 "Generation mechanism and prediction of windstorm in the mountainous coast" for 2006 ~ 2008.

HYDROSPHERE-LITHOSPHERE INTERACTION IN INFRASONIC AND SOUND RANGES

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Application of laser-interferometer methods to the research of wave fields in the ocean and lithosphere made it possible to receive new fundamental results on physical processes of interaction between the geospheres in the transition zone. Generation, dynamics, and geosphere boundary transformation of wave processes, such as inflow, seiche, superficial wind, and internal oceanic waves are investigated using data from the 52.5 - meter laser strainmeter established at the Shults Marine Station, POI FEB RAS. The basic results are received due to non-conventional application of unique laser-interferometer methods to studying oceanic processes and transformation of their energy at the hydrosphere–lithosphere boundary. Our research revealed unique opportunities of coastal laser strainmeters for studying physics of oceanic infra-gravitation waves playing a significant role in formation of structure and configuration of surf zone and coast. This, in turn, affects economic activities in ports and coastal waters. Loading effect of daily and semidiurnal inflow on microdeformations in the Earth's crust is estimated using the equal-arm and non-equal-arm laser strainmeters. It is found that separate super-low-frequency fluctuations of the Earth can be caused by seiche in the adjacent oceanic areas. It is determined that energy of oceanic internal waves is transformed into energy of elastic fluctuations of the seabed. Formation of the first and second order microseisms caused by interactions of standing and progressive oceanic waves with the shelf seabed are investigated.

INTERDECADAL OSCILLATION OF THE JAPAN SEA PROPER WATER RELATED TO THE ARCTIC OSCILLATION

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Cause of interdecadal oscillation of the Japan Sea Proper Water (JSPW) is investigated with hydrographic and meteorologic dataset observed in the Japan Sea and Arctic Oscillation (AO) index. Dissolved oxygen (DO) of PM5 shows clear interdecadal oscillation with an increase since 1980. And variations of AO show remarkable resemblance to DO throughout all the years from 1970s to 2000 with a correlation coefficient (hereinafter CC) of +0.66. This high correlation indicates JSPW could be influenced by decadal scale modulations in the North Pacific winter atmosphere field expressed as AO and such kind of large scale climate changes. After extracting the cold-air outbreaks using wavelet analysis with scale-averaged wavelet spectra (period: 5-15 days) from wind data of Wajima Station, signified CC between outbreaks and AO of +0.61 could be seen. The result validates the theory brought up by Isobe and Beardsley (2007) that warm winters of positive AO phase could cause more intense cold-air outbreaks over Japan Sea. Meanwhile, CC between SST of JSPW formation area and cold-air outbreaks is -0.62 and CC between SST and DO is also high of -0.74. The high correlations indicate, with the increasing frequency of cold-air outbreaks since 1980, SST in the formation area began to decrease and simutaneously DO increased. These results suggested that positive AO could lead to more intense cold-air outbreaks over Japan Sea which decreases SST largely in the JSPW formation area. Together with the strong wind stirring effect, the dense surface water sinks to deeper part or even the bottom forming the new JSPW and maintaining the thermohaline conveyor belt of Japan Sea. While during negative AO phase, opposite phenomenon appears. The whole above indicate typical processes of coupled atmosphere-ocean interactions happened in the East Asian marginal seas. And the decadal scale changes of AO could accompany significant changes in the hydrological cycle of Japan Sea, here represented by interdecadal oscillation of JSPW formation.

RUSSIAN RESEARCH VESSELS

Danchenkov M.A. and Volkov R.N.

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The first Catalogue of Russian Research Vessels is presented. The Catalogue includes 3 parts (List of Vessels, List of Shipyards, List of Projects), Collection of Photos, Description of Vessel's Names, History of the Russian Research Fleet, and Bibliography.

Ships belonging to Geological, Oceanographic, and Fishery Agencies, Polar Ocean Hydrography and Navy Hydrography Agencies, and Satellite Service are considered as research vessels in case of the official registration or appropriate referencing.

There are about 1700 vessels listed, with the tonnage of more than 100 t, from 1879 till 2008. Hydrographic vessels, with the tonnage of more than 500 t, and fishery research ships, with the tonnage of about 300 t, are most numerous. Description of the vessels includes 22 parameters, such as years of their use in research, displacement, builders, owners, dimensions, propulsion, crew/research staff lists, and homeports. Illustrations of the principal Research Vessels belonging to different agencies are also included.

REGIONAL ALGORITHM FOR RETRIEVAL OF SEA ICE PARAMETERS ON THE BASIS OF MICROWAVE MEASUREMENTS BY AQUA SATELLITE

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Microwave measurements by AMSR-E sensor on board of Aqua satellite are used to retrieve global ice concentration by application of several well known algorithms. Analysis of data products obtained with the use of these algorithms for the Okhotsk Sea region suggests that their accuracy can be improved. Merged dataset of ice concentration maps is created by Basic Bootstrap and NASA Team 2 algorithms from narrow-band albedo fields retrieved from cloudless daytime Aqua MODIS visible images. Envisat ASAR, Aqua AMSR-E, NOAA AVHRR IR/Visible data and other ancillary data are also used. The dataset is used for development of a new regional algorithm for the Okhotsk Sea which makes it possible to retrieve information on ice type with the spatial resolution of 6x6 km. Validation is performed to assess the algorithm

performance. The results indicate good agreement with other kinds of satellite data.

Applications of the new algorithm are discussed, including its potential for retrieval of sea ice parameters in the Bohai Sea.

THE BIFURCATION DYNAMICS OF THE KUROSHIO IN THE EAST CHINA SEA AND TO THE SOUTH OF JAPAN STUDIED FROM OCEANOGRAPHIC AND SATELLITE DATA

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The well-known property of ocean currents to be subjected to periodic in space and time branching (bifurcation) depends on many factors of their nonlinear dynamics.

The present analysis is based on data of research cruises of KISZ-80, KETI-82, and the "SECTIONS" programs performed by FERHRI, Vladivostok, in 1980-1991. Data of TINRO (Pacific Scientific Fisheries Research Center) cruises in 1970-1990, satellite observations in visible and IR-ranges, and deep-sea data from the Levitus (2005) database are also involved, as well as data on ARGO trajectories published by JMA in Monthly Ocean Reports.

The results show that the most complex bifurcation dynamics of Kuroshio is observed in the northern East China Sea where the Tsushima Current flowing to the Japan Sea and the Yellow Sea Warm Current separate from the main stream, while its major portion flows through the Tokara and Osumi Straits to Pacific. This is corroborated by the analysis of ARGO drifters trajectories characterized by chaotic behavior of separate jets emerging in various directions from the main stream and by the increased eddy activity in the Kuroshio bifurcation area.

Spread between extremum values of thermohaline characteristics throughout a year, thereafter referred to as amplitude, is analyzed in the upper 600 m layer in the area at 28°-33°N, 125°-130°E. This is the recruitment area of the southern sardine-iwasi with the areal in the Korean and Japanese territorial waters. Interannual variability of the temperature amplitude is also subjected to the chaotic quasi-periodic dynamics. For example, temperature amplitude at different depths is characterized by different kinds of trends for 1960-2000, estimated from more than 2500 stations. A decreasing trend of temperature amplitude is found in the surface mixed layer, while positive trends are found at 200 and 600 m depths. A week positive trend is found in the intermediate 300-

400 m layer. These trends are observed on a background of irregular oscillations on different time-scales, varying from 2-3 to 12 years and related to the non-stationary bifurcation dynamics of the Kuroshio Current.

Thus, different, in the vertical, layers reveal different periodicities and amplitude characteristics. The smallest amplitudes are observed in the 100-400 m layer. An interesting feature in the 600 m layer is a sharp (5-6 times) reduction of temperature amplitudes from 1978 to 1990. Nothing of this kind occurred in other years and this fact has not yet received an explanation.

The bifurcation dynamics of the Kuroshio to the south from Japan was discussed by Darnitskiy and Pokudov (1996; unpublished manuscript) and by Bulatov (2000, 2005). Study of dynamics in the Kuroshio “hot spots” is important for understanding of behavior of populations and the migration of the younger marine organisms in bifurcation areas (Bulatov, Darnitskiy, Savin, 1999).

Bifurcations around the Subarctic Front and Kuroshio to the east from Japan where they appear as tree bifurcations have been discussed earlier (Darnitskiy, Kanevskiy, 2006).

DEFORMATION METHOD OF TSUNAMI MONITORING

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Deformation method of tsunami detection is most effective, as the speed of the deformation motion in the elastic environment is more than an order of magnitude higher than the speed of tsunami propagation. Therefore, early tsunami warnings are possible, using this method. Methods of tsunami detection from oceanographic data are not effective, as the source-to-recorder distance is almost always not long and there is not enough time for effective actions.

The deformation anomalies causing tsunami result from various geodynamic processes. As a rule, these anomalies are related to earthquakes. Wide frequency range equipment capable to register deformation motions and detect deformation anomalies resulting in tsunami is necessary. Laser strainmeters can be used as such equipment. One of these devices, non-equal-arm 52.5 m long laser strainmeter is established in Primorski Krai, Russia. It has the measurement accuracy of the Earth's crust microfluctuations of 0.1 nanometers, working frequency range from 0 to 1000 Hz, and practically unlimited dynamic range.

From data received using the 52.5-meter laser strainmeter, tsunamigenic earthquakes were revealed on September, 5 and on December, 26, 2004.

Deformation anomaly causing tsunami was observed in the laser strainmeter records, which was not found during non-tsunamigenic earthquakes.

TO BIOLOGY OF HOLOTHURIANS: SOME COMPARATIVE CHARACTERISTICS OF *APOSTICHOPUS JAPONICUS* AND *EUPENTACTA FRAUDATRIX*

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A sea cucumber *Apostichopus japonicus* is of both dietary and pharmacological value, and the development of technologies of its mariculture is an important task. Holothurian *Eupentacta fraudatrix* is also a prospective object of mariculture. However, its biology is poorly known. The distribution of two species of holothurians in Alexeev Bay (Peter the Great Bay), the activities of antioxidant enzymes, and levels of heavy metals in tissues of those animals were studied in May, 2008. Both of species studied had the similar in many respects demands to salinity and quantity of water. However, as a whole, activities of glutathione reductase (GR) and catalase in coelomic fluid of *E. fraudatrix* were higher than those in *A. japonicus,* and, on the contrary, activities of superoxide dismutase (SOD) and glutathione S-transferase in *A. japonicus* were higher compared to those in *E. fraudatrix.* No sufficient differences in activities of GR and GT were found between different groups of age in both species, but significant differences were noted in SOD and catalase activities. The level of heavy metals was low in tissues of both species studied. However, the levels of Pb, Zn, Mn, and Fe were different in two species. The data obtained indicate that there is a similarity between the conditions of habitation of two species that apparently permits their co-culture. Nevertheless, certain physiologic differences found between species can influence on their adaptation capacities and has to be taken into consideration.

The work was supported by grant of *FEB RAS* № 07-III-D-07-070.

CIRCULATION FEATURES IN THE NORTHERN JAPAN SEA

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The Primorye (Liman) Current appears as a continuous flow in the years of the so-called cold type. It consists of separate jets at the western margins of several cyclonic gyres developing in the years of the so-called warm type. In autumn the Primorye Current is detected in the subsurface layer due to the increased Ekman drift and buoyancy loss. Variability of the Primorye Current is governed by the change of thermohaline water structure in the divergence zone. In the "warm" years the Primorye Current is fed by the outflow from the Tatar Strait, while in the "cold" years it flows at the western margin of the large cyclonic gyre in the northwestern Japan Sea. Dynamics of the Primorye Current is closely related to the intensity of the Tsushima Current. In summer – autumn of the "warm" years the typical feature is the formation of large cyclonic eddies related to the Primorye Current and of large anticyclonic meanders of the Tsushima Current. The latter carries warm water towards the Primorye coast.

The northern branch of the Tsushima Current in the Tatar Strait is intensified in the "warm" years. This is accompanied by the strengthening of the Shrenk and Primorye Currents. In the "cold" years the Tsushima Current branch weakens, while the Sakhalin Current strengthens. In summer the circulations in the surface and bottom layers differ in the northern Tatar Strait. In the southern, deep part of the Tatar Strait the geostrophic circulation is cyclonic in the west and anticyclonic in the east. The northern branch of the Tsushima Current, Primorye Current, and the Western Sakhalin Currents are the permanent circulation features, while the Shrenk and Sakhalin Currents are transient.

THE ANALYSIS OF POLLUTION IN THE AMUR BAY

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Influence of human and economic activities on river and oceanic ecosystems has led to constant deterioration of quality of river and sea water. So, the basic sources of water pollution in the Amur Bay are outfalls of industrial and household sewage, sea transportation, river discharge, and dumping.

The most polluted area of the Bay is its northern part where the largest river of Primorski region – Razdolnaya River – inflows to. This river carries the major portion (85%) of total sediment entering the Amour Bay. Excess of maximum permissible concentration of total and suspended matter is 81.67 and 15.15 times, respectively. According to the calculated pollution index, waters of the northern part of the Bay belong to the IV pollution class and waters in different locations of the eastern part of the Bay belong to the IV, V, and VI

pollution classes, respectively. Average concentrations of total and suspended matters at the eastern coast of the Amur Bay, within Vladivostok, amount to 13406.9 tons and 11786.73 tons and 74.33 and 9.8 times exceed permissible concentration limits, respectively.

From analysis of pollution distribution for the warm period, considering current variability, it has been revealed that the process of auto-purification is intensive in the Amur Bay. Zones of the increased concentration occur only near the dump sources.

Maximum concentration of suspended matters was observed near the dump sources, and the sediments were further dispersed along the east coast and to the bottom layer of the northern part of the Amur Bay. So, if suspension concentration reaches 6-8 mg/l near the coast, it is about 2 mg/l in the middle of the Bay. Local suspension anomalies were found in the zones of wastewater outfall and near river outlets. In the shallow northern part of the Bay there is accumulation of impurities, with the increase by $1*10^{-5}$ t/м^3 in a year. The pollution front tends to migrate to the open part of the Bay with the speed of 0.51 km/years. Patterns of high concentration correspond to the circulation patterns.

Obtained data are available in the newly developed geo-information system for ecological monitoring of the Amur Bay. Estimations of sea water pollution and main hydrochemical parameters are also presented, as well as evaluation of its biological consequences.

MESOSCALE VARIABILITY OVER CONTINENTAL SLOPE AND SHELF IN THE NORTHWESTERN JAPAN/EAST SEA

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The synoptic scale, seasonal variability of dynamical processes over the continental slope and shelf of the Northwest Japan/ East Sea including Peter the Great Bay is simulated using the MHI numerical layered model (Shapiro, 1998, 2001) of ocean circulation. We simulate the nonlinear mesoscale eddy dynamics over the shelf, continental slope, and Japan Basin taking into account realistic bottom topography and daily mean external atmospheric forcing. The model domains is the Japan Basin area with high resolution grid (about 2 km). The near-surface atmospheric fields was formed based on NCEP/NCAR Reanalysis.

The numerical experiments with minimized coefficients of the horizontal and vertical viscosity show the intensive mesoscale dynamics, particularly, synoptic scale variability of anticyclonic/ cyclonic eddies and streamers over the shelf and continental slope. The anticyclonic eddies generated over the shelf break and continental slope are usually moving southwestward along the slope like the topographic Kelvin waves with prevailing phase velocity of about 6-8 cm/s. The spatial scale of the anticyclonic eddies is usually increased near the Peter the Great Bay shelf where it exceeds significantly the baroclinic Rossby deformation radius.

The current system and mesoscale dynamics over the continental slope and Peter the Great Bay shelf is substantially changing from summer to winter. The strong northeastward boundary jet current is formed near the western coast of the Peter the Great Bay from late October to November when the monsoon is already changed from the summer type to the winter one.

The simulation results are compared with the data of the oceanographic and satellite observations.

THE NUMERICAL SIMULATION OF SEASONAL VARIABILITY OF SEA WATER CIRCULATION IN THE OKHOTSK SEA

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The aims of present study are the numerical simulation and research of sea water circulation in the Okhotsk Sea and the water exchange between the Okhotsk Sea and Pacific Ocean. Okhotsk sea circulation model is based on the RIAM Ocean Model (RIAMOM) with 1/18° horizontal resolution. The model domain covers the whole area of the Okhotsk Sea, Northern part of Japan Sea and North-Western part of Pacific Ocean whish wash the eastern coast of Kamchatka peninsula, Hokkaido and Kuril islands.

The fields of input data was formed based on NCEP/NCAR Reanalysis, The World Ocean Atlas 2001 (WOA01), The Global Monthly River Discharge Data Set (RivDIS v1.1) and NOAA Optimum Interpolation 1/4 Degree Daily Sea Surface Temperature Analysis. The boundary condition was generated based on the results of the Pacific Ocean model 1/6°.

The ocean model successfully reproduces the main features of sea water circulation in the Okhotsk Sea, namely: West-Kamchatka, Penzhinskoe,

Jamskoe, Middle, Northern Okhotsk, East Sakhalin, North-Eastern and Soya Currents, Northern Okhotsk, Slope and East Sakhalin Countercurrents. The structure of sea water circulation has a strong monthly variation.

The water exchange between the Okhotsk Sea and Pacific Ocean exist mainly through Fourth Kuril, Kruzenshterna, Bussol, Friza and Ekaterina straits. The inflow to the Okhotsk Sea exist through the Fourth Kuril and Bussol straits with the water discharge equal to 0.4 Sv. and 1.1 Sv. respectively. The flow from the Okhotsk Sea to Pacific Ocean exist through the Kruzenshterna, Friza and Ekaterina straits with the water discharge equal to 0.4 Sv., 1.1 Sv. and 0.4 Sv. respectively.

ON ESTIMATION OF OCEANIC FRONT LOCATIONS FROM SATELLITE MEASUREMENTS

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Satellite oceanography has opened new opportunities for studies of spatio-temporal variability of fronts in a wide range of scales. An attempt is made to formalize concepts of an oceanic front and a frontal zone with the purpose of their detection from satellite measurements. The frontal zone is represented by a flow convergence zone, while a line of maximum convergence in this zone is considered as a front. Dynamic fronts are detected from satellite altimetry data, thermal fronts are detected from infrared satellite data, and biotic fronts are detected from satellite ocean color data representing water transparency, chlorophyll concentration, and primary production. Examples are given for the Japan and White Seas.

PRESENT SITUATION AND PROSPECT OF A FERRY BASED MONITORING IN EAST ASIAN MARGINAL SEAS

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The East China Sea (ECS) is connected with the South China Sea by the Taiwan Strait and with the Japan Sea by the Tsushima/Korea Straits. Waters through the Taiwan Strait are thought to play important roles in circulation of

the ECS and in material transport in and out of the ECS, but direct current measurements are limited and temporal variation of volume transport through the strait is not well known. In the Tsushima/Korea Straits, velocity structure of the sea water has been monitored using ship-mounted ADCP system installed on the Ferry boat *Camellia* for more than 11 years. From that data, characteristics of current structure and volume transport through the straits are estimated and help in understanding the circulation and hydrography of the Japan Sea. The velocities and volume transports obtained by *Camellia* have been applied to validations and as boundary conditions of numerical models for Japan Sea circulations, and for Japan Sea forecasts based on data assimilation. As in the Tsushima Straits, we have a plan to start a ferry based monitoring in the Taiwan Strait from Nov. 2008. Such ferry based monitoring will be a powerful means to monitor environmental changes in the ECS, and of validations and boundary conditions of numerical forecast models for the ECS which have actively developed among East Asian countries.

INFLUENCE OF THE CLIMATE CHANGE TO FORECAST OF MOLLUSKS ON MARINE FARMS IN THE PRIMORYE REGION (SEA OF JAPAN)

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Global climate warming influences cycles of development of mollusks. There is also a tendency for the larvae period to become shorter; the duration of the settlement period exhibits the least variability. From comparison of duration of all four periods in development of Japanese scallop *Misuchopecten yessoensis (Jay)* in 1970-1990 and 1999-2003 it can be concluded that the duration itself was not changed but max and min duration was decreased. Thus, it is obvious, that climate change at the present stage has its impact on ecosystem functioning and there are changes in biological cycles. To study these changes monitoring of the biological parameters in marine farms is necessary.

VARIABILITY OF WATER AND AIR TEMPERATURE ALONG THE COAST OF PRIMORYE (SEA OF JAPAN)

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In the east, Primorskiy Krai is washed by waters of the Sea of Japan and Tatarskiy Strait. Measurements of hydrometeorological characteristics of the considered coastal area have been made by hydrometeorological stations. The paper is devoted to the analysis of data for the periods of instrumental observations at these stations (1881–2007). Thus, at the stations of the Peter the Great Bay for the period of instrumental observations on the temperature of air it has been revealed a positive trend, while at the stations of the eastern coast a significant trend in the temperature of air has not been revealed. Significant influence on the water temperature distribution can be explained by advective factors.

A QUEST TO IMPROVE SONOLUMINESCENCE METHOD FOR THE DETERMINATION OF IONS IN LIQUIDS

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Sonoluminescence (SL) can be applied for measurements of concentration of metal ions in solutions. It has considerably better metrological characteristics than the atomic absorption method because it does not require substantial sample dilution. However, the use of SL method is limited to the cases of low concentration because of the low intensity of the metal emission in SL spectra. We found that the emission can be substantially increased by the increase of hydrostatic pressure and at low temperature of solution. This effect makes possible the substantial improvement of SL method.

SATELLITE INVESTIGATIONS OF POLAR LOWS OVER THE JAPAN SEA

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Winter mesoscale cyclones (MCs) are frequently observed over the Japan Sea where favorable conditions are for their development when cold air mass moves across relatively warmer water. MCs do not frequently appear at weather charts due to their small sizes, short life time (typically between 12 and 72 hrs) and development in data sparse regions. They are difficult to forecast because of their rapid evolution and movement. The main sources of quantitative spatial data to examine these systems are satellite observations and fields of

geophysical parameters retrieved from measurements conducted by various satellite sensors. Polar lows (PLs), the most intensive MCs, are considered as a subtype. Up-to-date definition states that a polar low is a small, but fairly intense maritime cyclone that forms poleward of the main baroclinic zone (the polar front or another major baroclinic zone). The horizontal scale of the PL is approximately between 100 and 1000 km and surface winds near or above gale force (Rasmussen and Turner, 2003). The MCs were detected by screening Terra and Aqua MODIS images acquired over the Japan Sea in 2002-2008. Analysis of satellite images revealed two main cloud patterns accompanying the PLs: comma-shaped cloud patterns and spiral ones. Spiral PLs have considerable similarity to tropical cyclones including the presence of a clear eye in the centre of the cloud vortex and a warm core. MODIS images of selected PLs are compared to QuikSCAT-derived wind fields, Aqua AMSR-E-derived fields of total atmospheric water vapor content, total cloud liquid water content, surface and upper-air analysis, and radiosonde reports.

LONG-TERM CHANGE OF TEMPERATURE IN RELATION TO CLIMATE-INDUCED CONDITIONS IN THE KOREAN WATERS

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We compared the annual amplitude change of surface temperature in the Korean waters during last 35 years using serial oceanographic investigation data. The annual amplitude of surface temperature is clearly decreased about 0.017°/year in the East Sea and slightly decreased about 0.002°/year in the Yellow Sea, though it is slightly increased about 0.003°/year in the South Sea. Different increasing rate of temperature at surface layer between winter and summer appeared in these trends. In winter, surface temperature sharply increased about 1.47°, 0.70° and 1.45° in the East Sea, South Sea and Yellow Sea in respective. On the other hand, surface temperature in summer also gradually increased about 0.47°, 0.81° and 0.71° in the East Sea, South Sea and Yellow Sea in respective. Except the South Sea, increasing trends of surface temperature are distinctively larger in winter than those in summer, especially in the East Sea. To examine the distinctive increasing trend of surface temperature in winter, we also compared air temperature and wind speed in winter around the Korean peninsula during last 39 years. Air temperature and wind speed in winter around the Korean Peninsula were clearly increased and weakened in respectively. These long-term changes should be closely related to

the weakness of Siberian High. Actually, Sea surface pressure at center of Siberian High was clearly decreased about 2~3 hPa in recent. Therefore, we can consider that long-term change of temperature in the Korean Water should be related with the long-term change of Siberian High.

THE SCREENING COMPOUND OF ANTI-INFLAMMATORY ACTIVITIES FROM VIETNAMESE SEAWEED

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In this study, 20 seaweed species of Vietnam including red, brown, and green algae which distributed from Northern to Southern part of Viet Nam have been screened to investigate the anti-inflammatory activity of common seaweeds available in Vietnam. The seaweed extracts were tested in Laboratory assays against in *in vivo* Arachidonic acid (AA) induced mouse ear inflammation model. With the extractive process application for the anti-inflammatory extracts by methanol solvent, the optimum conditions of screening the anti-inflammatory extracts from Vietnamese seaweed have taken 1 hour with 0.08mg/mL extracts. According to this method, a total 20 species showed the anti-inflammatory activities, of which two *Sargassum swartzii* and *Ulva reticulata* displayed strong suppressive activities against inflammation and possessed potential to exploit. The obtained result of anti-biotic test indicated that *Ulva reticulate* extract inhibited the activity against *Bacillus subtilis* with a 50% inhibitory concentration (IC_{50}) value of 62.15 μg/mL while *S. swartzii* - 56.53 μg/mL against *Staphylococcus aureus*. Furthermore, the extracts of *U. reticulata* and *S.swartzii* were tested the anti-inflammatory activities in animals (acute toxicity, analgesic by acetic acid, hot plate, suppressed the amiant granuloma as a subchronic inflammatory model, peritonitis by carageenane). The methanol extracts of *Ulva reticulata* and *S. swartzii* showed no toxicity to mice after an oral administration of 66 g/kg body weigh. *S. swartzii* and *Ulva reticulata* extracts at a dose of 500 mg/kg showed analgesic effects in both of analgesic test by acetic acid and hot plate models. *S. swartzii* extract at the dose of 500 mg/kg showed acute anti-inflammatory effect in both of edema in hind paw induced by carrageenane and peritomaeum's extravasations models. The only *S. swartzii* extract at the dose of 175 and 350mg/kg showed subchronic

anti-inflammatory effects. The obtained results are suggested that Vietnamese seaweeds can be used as remedies for reducing inflammation.

TOXICITY OF METAL MIXTURES (CU, HG, CD) TO MARINE INVERTEBRATES: *ARTEMIA, MUSSELS*

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The toxicity of any given heavy metal depends not only on the prevailing concentration in the medium, but its toxicity can be influenced by a variety of factors, among them the presence of other metals. Therefore, for most metals the toxicity threshold may be elevated or decreased due to the presence of other metals in the solution. Thus, this study addressed two aspects i) to see if low levels of a secondary heavy metal can influence the toxicity of a target metal and ii) to determine whether body concentrations were the primary causes of toxicity. The study results showed that the toxic effects of one metal in the presence of relatively another metal, can either remain unaffected (i.e. Cd toxicity in the presence of 0.1 mg/L of Cu), or decrease (i.e. toxicity of both Hg and Cu in the presence of 1 mg/L of Cd) or increase (i.e. Cu toxicity in the presence of Hg). The nature of the toxicity of a metal in the presence of another also appeared to also depend on the concentration of the secondary metal. This was observed for the toxicity of Cd in the presence of two levels of Hg and also for the toxicity of Hg in the presence of two levels of Cu. Overall, these results imply that toxicity data obtained from a single chemical exposure as is traditionally done in Environmental Risk Assessment (ERA) studies, may greatly overestimate or underestimate the actual impact of a particular metal in the real environment.

VARIATIONS OF THE TAIWAN WARM CURRENT AS SEEN BY ALONG-TRACK ALTIMETRY AND SURFACE DRIFTER DATA

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Velocity component normal to a subsatellite track of TOPEX/POSEIDON and Jason-1 northeast of the Taiwan Strait is estimated from trajectories of the surface WOCE drifters crossing the track. Geostrophic velocity anomaly determined from the along-track altimetry data is subtracted for each crossing, and then the mean geostrophic velocity is statistically estimated along the track. Two bands of northeastward velocity component are found north of 27.5N and at 26.7N in the mean. Monthly mean of the 13-year data indicates that the former band is strengthened in summer and disappeared in winter, which agrees well with the Taiwan warm current. Meanwhile, the latter band is significant only in winter when the Kuroshio tends to be weaker and move southward. High-frequency variations are also found dominant so that the Taiwan warm current may disappear even in summer in 10-day interval snapshot data.

LONG TERM CHANGE OF PRIMARY PRODUCTION IN THE YELLOW SEA AND EAST CHINA SEA

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Recently, environmental condition in the Yellow Sea and East China Sea is changing radically. Satellite ocean color data can be used to study 10 years change of chlorophyll-a distribution in the Yellow Sea and East China Sea. Seasonal analysis showed that the satellite chlorophyll-a and water leaving radiance was high in the coastal area during winter indicating that the possible overestimation of chlorophyll-a in the area by resuspended sediment. However, large area of middle of Yellow Sea and East China Sea showed clear spring bloom, indicating less influence of resuspension other than winter. Changjiang River plume extended to the Tsushima Strait can be observed during summer.

Area and concentration of high chlorophyll-a plume indicate significant variability depending on the discharge amount of the Changjiang River. Influence of Three Gorge Dam was not very clear for large scale ocean color information; however, it is expected that there will be significant change if there will be a significant change of freshwater discharge amount. In the Yellow Sea, magnitude of spring bloom increased last 10 years, and it may be indicating the influence of eutrophication. Those changes of ocean color information may be directly related to other environmental changes reported in the area.

SSH VARIABILITY IN THE NORTHERN JAPAN SEA STUDIED FROM SATELLITE OBSERVATIONS

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Sea surface height anomalies (SSHA) obtained from satellite altimetry. represent an important regular dataset, with the temporal coverage of more than a decade, well suited for studies of variability in the Japan/East Sea (JES). The 1/3° gridded weekly SSHA based on all available data from TOPEX/POSEIDON, Jason, and ERS-1/2 satellites for the period from October 1993 to July 2006 are available in frames of the AVISO Project. We examine SSHA, using Complex Empirical Orthogonal Functions (CEOF) analysis, in the entire JES and in its northern part. The northern JES is characterized by its own variability which is not evident when the entire JES is considered. The first mode (CEOF 1) for the entire JES can be considered as a seasonal signal. CEOF 2 reveals variability of the Tsushima, East Korea Warm Current, and Primorye (Liman) Currents. CEOF 3 manifests interannual variability in the Yamato Basin. As for the northern JES, CEOF 1 is similar to that for the entire sea, representing the seasonal signal. CEOF 2 is a seesaw between the northwestern and northernmost areas. CEOF 3 reveals a seesaw between the Primorye Current and branches of the Tsushima Current in the northeastern JES.

SEMI-ANNUAL SEA LEVEL VARIATIONS IN THE NORTH-WEST PACIFIC

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Semi-annual variability of sea level in the North-West Pacific is studied. The analysis is based on information from tide-gauge stations and satellite altimetry data in the North-West Pacific from the ERS-I, ERS-2 and Topex/Poseidon satellites. Sea level data were obtained from the Joint Archive for Sea Level (JASL). The altimeter products are produced by Ssalto/Duacs and distributed by AVISO (Archiving, Validation and Interpretation of Satellite Oceanographic Data - http://www.aviso.oceanobs.com/), with support from CNES (Centre National d'études Spatiales). An altimetry mission of high accuracy and long duration is ideal to study long-term sea level variability in the open sea. Nevertheless, measurements at tide-gauge stations which go back over 100 years are also good for control.

We use up-to-date methods of harmonic, spectral, and wavelet analysis of tide-gauge and satellite altimetry data. Hydrological features are discussed in terms of spatio-temporal distribution of annual and semi-annual fluctuations. Calculation and mapping of amplitudes and phases of annual and semi-annual sea level variations in the North Pacific is performed.

CROSS-SHELF WATER EXCHANGE OFF PETER THE GREAT BAY, THE NORTHWESTERN JAPAN SEA

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Peter the Great Bay is located on the extended shelf in the northwestern Japan Sea. The oceanographic conditions in the Bay are controlled by the wind-driven circulation and the cold southwestward Primorye Current flowing over the slope. One can expect substantial mesoscale dynamics in this area, related to the coastline/topography and wind variability. Flow instabilities resulting in current meandering and eddy formation are observed to intensify in the transition period from summer to winter monsoon (September – October), with the general strengthening and frequent events of very strong wind. NOAA infrared AVHRR images are analyzed for July-October 2000-2004. A large (80-

110 km) single anticyclonic (AC) eddy or several smaller eddies were detected in the Bay. Typical AC eddy diameters vary from 15-110 km. Eddie's lifetime changes from several days to some months. Fresh coastal water is transported across the shelf-break at the eddy eastern side and deep sea water is advected onto the shelf along its western side. Northeastward current can flow over the slope in the direction opposite to the Primorye Current. Numerical simulations with an oceanic model show that even under the smoothed monthly forcing AC wind stress curl prevailing over this area in summer – autumn induces AC eddy formation. However, if the model is forced by the large-scale cyclonic curl in summer, the Primorye Current simulated at the northwestern edge of the sea cyclonic gyre is so strong that the formation of AC eddies is suppressed, despite the AC wind stress curl in autumn.

THE UPPER OCEAN RESPONSE TO THE TYPHOON PASSAGE IN THE EAST CHINA SEA

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Though the upper ocean response to strong wind forcing, especially the passage of typhoon in summer, is of fundamental importance for understanding the mixing process of the surface low salinity waters in the East China Sea, the related study has been limited by the lack of direct observations. Recent deployments of satellite tracked drifters equipped with temperature and salinity sensors in the East China Sea provided a good data set to analysis the ocean response to the passage of typhoon. In August 2004, when Typhoons Rananim, Megi and Chaba passed over the East China Sea, seven drifters were deployed in the area southwest of Cheju-do by a Korea-Japan cooperative work. The drifters were generally moving to 30-50° right of the wind direction. The drifter movements changed sharply two days before the typhoon and the flow field pattern changed for a week after the typhoon passage. Three consecutive circular patterns in drifter trajectories indicating inertial motion with about 15 km radius appeared after the passage of Typhoon Megi.

CO-EVOLUTION OF GEOSPHERES IN RELIEF FORMATION OF SOUTH-WEST BAYS OF THE OKHOTSK SEA

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The study area (Tugurskiy, Ulbanskiy, Nikolai, Academy and Sakhalin Bays) includes the south-west region of the shelf of the Okhotsk Sea between 52° and 56° N. Features of the environment influencing relief-forming of the south-west region of the Okhotsk Sea shelf are revealed. The bottom of the west part of Okhotsk Sea represents the deep surface of the denudation leveling. This surface is complicated by small distinct trenches, continued spread of the depressions of the land. The coastline runs perpendicular to the basic geological structures of the sea margin. As a result, transgressions and regressions of the sea and movements of the coastal zone lead to building up level surfaces. Absolute marks of 110, 78-80, 68-70, 59-61, 21-24, 15-17, 0, and +5-+7 m are tracked. Sites of the Mesozoic and Cenozoic folding and sites of the marginal volcanic belt are characterized by a various tectonic conditions. These sites manifest themselves in a relief in the different way. The landscape-climatic features and the hydrological regime determine the modern development of the coast and seabed of the Bays. The cold Okhotsk Sea, long ice season, the weakened wave regime, strong tidal currents represent basic conditions of the modern relief-forming of the Bays. The morphogenetic belts are determined and characterized.

RESULTS OF ANTHROPOGENIC INFLUENCE ON MARINE ECOSYSTEMS: CASE OF PETER THE GREAT BAY, THE SEA OF JAPAN

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Significant part of coastal marine ecosystems of Peter the Great Bay is subjected to strong anthropogenic influences. In coastal areas of the Bay sewage waters contain polluting substances of mineral and organic origin. They are present in the sea water in dissolved, emulsified, and suspended forms. Annual

sewage discharge to Amursky, Nakhodka, and Gold Horn Bays is about 2.6%, 0.0017%, and 0.0006% of their total volumes, respectively.

Polluting substances result in nutrient misbalance and oxygen deficiency, as the significant part of it goes to oxidation of organic matter. In the strongly polluted areas of the Bays, with weak water exchange, oxygen deficiency creates a real threat for marine organisms. Enrichment of the coastal waters by biogenic elements results in eutrophication and increase of phytoplankton production. The structure of phytoplankton in hyper-eutrophic waters changes owing to reduction of biodiversity. In 1991-1995, diatom *Sceletonema costatum* amounted to 90-95% of the phytoplankton population in Amur and Nakhodka Bays, which is a known indicator of organic pollution. The so-called Red Tide caused by intensive procreation of microorganisms and cases of toxic seaweed are consequences of hyper-eutrophication of the coastal waters.

Evidence of degradation of benthic communities is revealed in many areas of the Bay. Benthic organisms are capable to accumulate toxic substances in their bodies and to transfer them along the food chains. Therefore, negative influence of pollution found out at different trophic levels represents a threat not only for lower organisms-bioaccumulators, but also for representatives of the higher trophic levels.

Extensive information on the conditions of the sea environment and structural and functional characteristics of ecosystems is necessary for studying consequences of anthropogenic influence on sea ecosystems. Use of the underwater vehicles equipped with various gauges, video-cameras, systems for gathering, recording, and processing information needed for estimation of ecological characteristics of marine ecosystems and their specific diversity is a highly perspective line of research.

MASS AND MOMENTUM TRANSFER BY BREAKING INTERNAL AND SURFACE WAVES IN COASTAL ZONE

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In coastal zones, shoreward propagation of surface and internal waves generally leads to breaking. The turbulence generated by breaking and mixing processes at the wave fronts induces the very effective mechanism of energy dissipation and momentum exchange between waves and nearshore currents leading to sediments suspension and transport. Nonlinear internal waves generated by tides, as well as by interaction of flows with topography, play an

important role in the energy transfer from the large-scale motion to small-scale mixing. Scotti & Pineda (2004) have recently observed bore-like structures with trapped cores in the near shore area of Atlantics. The transition from wave-like motion to the separate moving soliton-like structures ("solibores") containing trapped dense core is the common feature of the run up process of internal waves. It can be observed in any shelf zone with high internal wave activity as well as in laboratory experiments.

The evolution of breaking waves propagating towards the shore and more specifically the run-up phase over the swash-zone for surface as well as for internal waves is considered. The study is based on the laboratory run up experiments performed in LIH (Lavrentyev Institute of Hydrodynamics, Novosibirsk) and on the field data describing the internal wave run up from the joint LIH–POI (V.I. Il'ichev Pacific Oceanological Institute, Vladivostok) expedition in 2006-2007. The presentation is focused on the breaking and energy transfer mechanisms common to surface and internal waves in the swash-zone. The mathematical model taking into account turbulent mixing (Liapidevskii, 2004) is adapted to the problem.

COASTLINE MAPPING AND EVOLUTION WITH RESPECT TO AMPLITUDE, COHERENCE, AND PHASE INFORMATION OF ERS SAR TANDEM PAIR

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ERS Synthetic Aperture Radar (SAR) tandem pair with minimum possible temporal baseline of 1-day and with precise orbit control to obtain suitable interferometric spatial baseline is appropriate for interferometric study in terrain analysis. In this work, attempts have been made to characterize of the coastline evolution with respect to interferometric coherence and phase information of ERS SAR tandem data and backscattered amplitude information of ERS SAR and Envisat ASAR data. Interferometric coherence information represents temporal stability of terrain elements. The marine part of the coastline is always changing and therefore shows extremely low coherence whereas the land part particularly the beach area and dune field are stable for 1-day interval. Coastline is one of the rapidly changing land forms. The accurate demarcation and monitoring of shoreline (long term, seasonal and short term changes) are necessary for understanding the coastal processes. The historical and functional approaches to study shoreline changes along with various landforms help in deciphering the coastal processes operating in an area. The rate of coastline

change varies depending up on the intensity of causative forces viz., warming of oceanic waters, melting of continental ice.

THE ACOUSTIC MANIFESTATIONS OF MARINE HYDROCARBON SEEPS

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Gas and oil seepages in shallow submarine environments produce buoyant hydrocarbon plumes that are detected as sonar targets within the water column. A rising bubble plume forms an effective acoustic waveguide that possesses normal modes. The "birthing wails" of the bubbles as they depart from the vent is accompanied by generation of broadband noise. Thus a passive method for diagnostics of gas vents can be proposed. The noise spectral density has maxima at frequencies corresponding to the natural (collective) oscillations of the bubble cloud. The spatial distribution of noise in depth and in lateral direction is highly non-uniform and modal in nature.

Active acoustic (sonar) techniques can operate at a larger distances but are difficult to interpret. Investigations at the Sakhalin slope in the Sea of Okhotsk have identified localized venting of methane gas bubbles in association with gas hydrate occurrence. To find correlations between the upper boundary of the gas flare and the predicted depth of the gas hydrate stability, the model of hydrate coating has been derived. Based on this model, bubble scattering cross section has been calculated and the method for diagnostics of these hydrate-shelled bubbles has been proposed.

CONTRIBUTION OF SUBSURFACE WATER TO THE SALINITY INCREASE AND PRIMARY PRODUCTION IN THE CHANGJIANG DILUTED WATER

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Primary production takes place in the upper layer in the ocean, where light intensity is enough for photosynthesis but nutrients should be supplied. In the East China Sea, it is considered that significant parts of nutrients source would be in the river discharge from the continent. However, it is also pointed out that a considerable part of the nutrients supply to the shelf area of the East China Sea could come from subsurface of the Kuroshio, while we don't know well how much rate of the nutrients from the Kuroshio could be used for the primary production. Vertical exchange of water in the shelf area may not only result in the supply of nutrients from the lower layer but also significantly contribute to dilute the fresh water. During the observations with satellite tracking drifters, it was found that abrupt increase in salinity took place when a typhoon passed through the observation area. The abrupt increase in salinity could be caused by upward advection generated by divergence in the surface layer as well as vertical mixing by strong wind of the typhoon. Wind field in the shelf area can give the divergence/convergence fields. A part of the salinity increase obtained by drifters could be generally explained with the divergence in the region. The other reasons expected for the salinity increase such as the vertical diffusion were also estimated from the direct measurements of the microstructure.

SATELLITE SAR SUPPORTING OF EXPERIMENTS IN THE EAST ASIAN SEAS

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Satellite Synthetic Aperture Radar (SAR) is an instrument well suited for detection and investigation of the oceanic dynamic phenomena and sea ice. At present, SAR images of the ocean can be obtained from ERS-2, Envisat, RADARSAT-1, RADARSAT-2, ALOS and several recently launched Italian and Germany satellites. SARs provide high resolution information on the sea surface features independently on sun illumination and cloudiness that is important for both coastal and open ocean experiments. In turn, the coastal and ship observations of hydrological and meteorological parameters influencing radar backscatter help to improve the SAR signature interpretation and advance calibration of radar signals. The location of SAR image boundaries and time of observations are known in advance that allows planning their acquisition over the areas under study. Examples of SAR supporting of the experiments at POI Marine Experimental Station Cape Shults in 2004-2007 and in the open areas of the Japan Sea (1999) and the Okhotsk Sea (2004-2007) are given in a paper. Comparison of SAR signatures caused by coastal fronts, eddies, internal waves

and sea ice with close in time visible and infrared satellite images and ship measurements is carried out demonstrating importance of 2D information on the sea surface obtained at the different ranges.

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CURRENT STATE AND OUTLOOKS OF PASSIVE MICROWAVE SENSING OF THE OCEAN-ATMOSPHERE SYSTEM

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Since the first microwave observations of the Earth carried out 40 years ago by a four-channel radiometer from Kosmos-243 satellite, passive microwave sensing became a mature branch of remote sensing, with multiple applications. Independence from sun illumination, opportunity to observe the underlying surface in spite of cloudiness, and high sensitivity of brightness temperatures T_B to such parameters as sea surface temperature (SST), sea surface salinity (SST), wind speed W, sea ice concentration C, total atmospheric water vapor content V, total cloud liquid water content Q, etc. are especially important for studies of the vast oceanic spaces. In this paper the main attention is focused on algorithms for retrieval of geophysical parameters and on analysis of Aqua AMSR-E measurements over the Northwest Pacific Ocean. An advanced program of microwave radiative transfer in the ocean-atmosphere system is described. The simulated T_Bs at AMSR-E channels were used for development of linear, nonlinear, and physical-based retrieval algorithms. The algorithms were tested and tuned by comparison of retrieved field of parameters with fields derived by other satellite sensors as well as with *in situ* data. Case studies cover the marine weather systems including extreme weather manifested themselves in the V, Q, W, and SST fields. A brief overview of microwave sensors currently flying (SSM/I, TMI, WindSat, AMSU-A, AMSU-B, etc.) and firmly planned (SMOS, Meteor-3M, GCOM-1, etc.) is given.

THE STATUS OF SILVER POMFRET FISH *PAMPUS ARGENTEUS* POPULATION AFTER EXPOSURE TO ECOLOGICAL CONSEQUENCES IN 1980-2005 IN IRAQI MARINE WATERS, NORTHWEST ARABIAN GULF

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The status of silver pomfret *Pampus argenteus* population in Iraq marine waters, north-west of the Arabian Gulf was assessed from March 2004 to July 2005 and compared with the status of this species during the periods of 1989-1990 and 1997-1998. A total of 1929 specimens of *P. argenteus* were collected, their lengths ranged from 10 to 36cm. Length-weight relationship was obtained as W= 0.0466 L^ $^{3.0725}$. The relative condition factor ranged from 0.95 in September to 1.05 in April. Growth and mortality parameters estimated were: L∞= 42.4cm, K= 0.53, Z= 2.15, M= 1.25 and F= 0.9. The current exploitation rate (0.42) of *P. argenteus* was lower than the optimum level (0.5). A bimodal recruitment pattern of unequal strength was observed. The maximum yield per recruitment could achieved at E_{max}= 0.50. The study reveal that the total and natural mortality rates were higher than that for the same population during the last two decades, and the exploitation rate was lower than that of the late of ninetieths.

OCEANOLOGICAL ZONNING OF THE RYUKYU STRAITS AND THE ADJACENT AREAS OF THE EAST CHINA SEA AND PHILIPPINE SEA

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Resources of the Pacific Oceanological Institute (POI FEB RAS) data base including archive materials of national research cruises, data of field observations carried out by the POI FEB RAS in 1977-1993, observations from Japan research cruises in 1998-2005, and the global array of the average long-term hydrological data for more than semi-centennial period covering the entire Northwestern (NW) Pacific are applied for studying thermohaline structure and dynamic features in the area adjacent to the Ryukyu Islands. Zoning of water

structure is performed. The role of the Ryukyu Straits in forming water characteristics of the Kuroshio Current in the East China Sea is analyzed. Response of water structure in the current zone to variability of water exchange through the straits is revealed. Influence of shelf waters in the East China Sea is also investigated. It is shown that the transformed Pacific Ocean (Philippine Sea) waters are supplied to the Kuroshio Current in the sub-strait zones of all relatively deep water straits. New information about variability of hydrological characteristics is obtained.

DYNAMICS AND IMPACT OF OCEANOGRAPHIC RESEARCH IN THE EAST ASIA: A BIBLIOMETRIC STUDY OF CO-OPERATION

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Bibliometric analysis of scientific literature on oceanographic research in East Asia countries was performed. Thomson-Reuters Web of Science (WoS) SCI-EXPANDED database was used as a main source of bibliographic records published in 1975-2007. We analyzed more than 8400 records of oceanographic papers published by authors from these countries and retrieved from WoS using ADDRESS field and refined search results by SUBJECT AREA "Oceanography". Among oceanographic publications there are marine biology, fisheries and marine/ocean engineering papers which account for 20%, 15% and 9%, respectively. The main player in the North Pacific oceanography is U.S.A. (45% of all publications); Japan (18%), Canada (5%) and China (5%) are the next players among 80 counties doing scientific research in North Pacific. Publication trends of two Asian Tigers (Taiwan and South Korea) display the highest rates (42% and 32% per year, respectively) of growth of total number of papers. If these trends continue in the next fifteen years, only five main players will remain in the region, with 15-18% share of all publications. They will be the U.S.A., Japan, China, Taiwan and South Korea. The analysis shows that in U.S.A. and Japan only a quarter of North Pacific studies is made in collaboration with other countries, whereas in Canada, China, Taiwan, South Korea, and Russia a half of research is made in cooperation. Trends in dynamics of scientific outputs and temporal changes in scientific cooperation are discussed.

SEASONAL VARIATION OF MODELED LIMAN COLD CURRENT OFF THE PRIMORYE COAST

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Seasonal variations of Liman Cold Current (LCC) off the Primorye coast were examined in terms of its strength and cross-sectional structures obtained from both high resolution numerical (RIAMOM) and simple analytic models. The numerical model simulated the LCC which becomes stronger twice (both in summer and winter) a year with two velocity cores in summer and one in winter. The analytic solutions were for wind-forced, two-layered, cross-sectional coastal model with idealized shelf topography, and showed annual change of alongshore velocity in the upper layer. The analytic solutions were consistent to the numerical simulations in strength and cross-sectional structures. Comparison of the analytic model solutions with and without changing stratifications suggests that the LCC were driven mainly by wind forcing in winter and by buoyancy forcing in summer. The buoyant coastal water in summer may primarily originate from the Amur River discharge and melted sea ice, and partly from the excess of precipitation to evaporation.

OBSERVATIONS AND MODELING OF INTERNAL WAVES IN THE SHELF ZONE OF THE SEA

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Internal waves (IW) are universal phenomenon in the ocean, extremely important in the coastal ocean. Observations of IW in the shelf zone of the Japan Sea were performed with the use of different devices: vertical probing along transects, towing of liner sensors, series of probing in fixed points etc. Based on these observations and concurrent modeling, we investigated such phenomena as IW generation near the shelf break, their propagation and transformation, fine structure formation, vertical and horizontal diffusion amplification.

At present we experimentally and theoretically study processes in a shoaling thermocline, which include IW and turbulence. Their combined effects in the near-bottom thermocline lead to intense vertical mixing, sediments transport by specific horizontal currents, and some other phenomena. These processes are simultaneously studied in the sea and in laboratory by scientists from the Pacific Oceanological Institute FEB RAS and the Institute of Hydrodynamics of Siberia Siberian Branch of Russian Academy of Sciences. Some preliminary results are shown in the presentation.

THE EFFECT OF UNUSUAL NATURAL CHANGES ON CORAL REEFS IN THE CON DAO NATIONAL PARK, VIETNAM

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The Con Dao National Park was established since 1983 with a total area of 20,000 ha, of which marine area is 14,000 ha and the rest is island area. The Park has been one of the most pristine and healthy coral reefs in Vietnam both on richness in number of species, area and coverage accompany with high marine biodiversity, many valuable, rare and endangered species living here. In recent years coral reefs in the Con Dao have been rapidly degraded, some reefs completely dead, coral reef ecosystem have been strongly changed that leads to loss of marine biodiversity, natural resources and habitats. The causes of this event related to global climate change such as unusual changes of storm direction, fresh water run off reach to the islands that never occurred before. Some solutions on reef restoration have been suggested in which zoning and coral transplantation is main objectives for Con Dao National Park.

SURFACE CIRCULATION AND GEOGRAPHIC DISTRIBUTION OF MESOSCALE EDDIES IN THE JAPAN SEA

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Occurrence of mesoscale eddies in the Japan Sea was analyzed from infrared satellite imagery for 1988-1996. Analysis of satellite imagery, ship observations, and published data revealed that warm (anticyclonic) mesoscale eddies can be persistent features in the Japan Sea. A new generalized scheme of the surface circulation in the Japan Sea is suggested, considering the stationary eddies bound to current jets. The suggested scheme differs from the well-known Yarichin's scheme (1980) by the addition of seven anticyclonic eddies and, in the eastern sea, of a cyclonic eddy. These eddies are closely intermingled with the large-scale currents which envelop them. This scheme is consistent with positions of the thermal fronts in the Japan Sea (Nikitin, 1996). The East Korea Warm Current (EKWC) features two stationary eddies. The Tsushima Current in the eastern Japan Sea is represented by the nearshore and second branches. A stationary eddy is located at the margin of the second branch northward of Noto Peninsula. Another eddy is located over the Yamato Rise. The circulation scheme features two chains of warm eddies along 131°E and 134°E, providing pathways of warm water transport towards the coast of the southern Primorye, Russia. This process contributes to the long and warm fall season in the southern Primorye. Similarly, the long and warm fall season is characteristic of the middle and northern Primorye, between 43°-45°N and Zolotoy (Golden) Cape. The Primorye Current is not considered as the continuous flow (Yarichin, 1980) but rather as two streams with the discontinuity at 43°-45°N. The discontinuity can also occur off Peter the Great Bay. Small anticyclonic and cyclonic eddies are detected along the Primorye coast. The Shrenk Current flows along the continental coast at 46°-48°N. Winter 300 m temperature and temperature in the 600-600 m layer obtained from ALACE floats correspond to the suggested circulation scheme.

DYNAMICS AND TRANSFORMATION OF INFRAGRAVITY AND WIND WAVES

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Results of processing of experimental data on microdeformation variations of the Earth's crust from the coastal laser strainmeter in a range of infragravity waves are discussed. The correlation of these oscillations with sea roughness allows one to conclude that their source is in the sea. Results of measurements show that ratios between amplitudes of the oscillations caused by infragravity waves and surface roughness considerably differ from the ratios reported in the literature. It can be explained by the fact that laser strainmeters are capable to

register integrated characteristics of wind and infragravity waves, allowing more precise estimations of the ratios.

BOTTOM TURBULENCE OF BREAKING INTERNAL WAVES IN A COASTAL ZONE OF THE SEA OF JAPAN

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The process of development of the near bottom turbulence is investigated in the "swash zone" of breaking internal waves, i.e. in the zone above the contact line of the main thermocline with the bottom. The high frequency temperature oscillations in the bottom layer are analyzed in the field experiments on the shelf of the Sea of Japan during the propagation of the internal waves in the run-up region. The high frequency range corresponding to the small scale turbulence generated by breaking internal waves is revealed from the calculation of the energy spectra of the temperature oscillations. The dependence of the energy spectra of the temperature oscillations in the high frequency range is in a good agreement with the power law $E_T(f) \backsim f^{-3}$ in accordance with the Kolmogorov hypothesis.

VARIABILITY OF INTERNAL WAVES IN THE SHELF ZONE OF THE SEAS OF WESTERN PACIFIC

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In this work the analysis of spatial variability of internal waves (IW) in the shelf zone of a sea is performed. Parameters of internal waves are calculated by the simulation of free IW in linear approach. The cross-shelf transects for the seas of western Pacific (Sea of Japan, Sea of Okhotsk, Philippine Sea) are chosen as initial data for IW parameter calculations. The distribution of hydrological characteristics in the chosen transects is typical for shelf zones of these seas during the density stratification period.

Rapprochement of dispersive curves at some interval of high frequencies occurs for a slope and for a shelf of the seas. This interval corresponds to the

zone of resonant interaction of different modes which appears only at presence of the thin vertical structure of a density field.

The sharp increase in wave numbers above a continental slope and the existence of the maximum at the shelf break is the common feature for all seas under consideration. In a shelf zone the behavior of dispersive curves depends on its width and vertical structure of buoyancy frequency. The bottom topography almost does not influence the lowest modes of IW, while the wave number dependence for high modes can have maxima and minima. The spatial structure of wave numbers for various modes depends on stratification and on a bottom steepness.

QUATERNARY–RECENT GEODYNAMICS STATUS OF SHELF ZONE OF SOUTHERN CENTRAL VIETNAM

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The structural, tectono-physic and seisomo-tectonic analyses have clarified the Quaternary–Recent geodynamic evolution of coastal- and shelf zone of Southern Central Vietnam and adjacent area.

As a result of Neo-tectonic activities, Southern Central Vietnam had gained a typical tectonic-structural shape, with sharp on the relief East Vietnam Fault scarp, which is running in the north-south direction and somewhat, is dividing the region into two different zone: The mainland Indochina geo-block in the west and pro-oceanic terrains in the east.

The East Vietnam Fault Scarp had been acting as normal-right strike slip and had contributed to spreading of the East Vietnam Sea, which was stopped at 15.5 My ago.

The late Cenozoic period of the region was characterized by several volcanic eruption episodes, which can be seen very well on the seismic sections and other geomorphologic data. While the volcanic activities on the mainland in general was stopped 400,000 ago, some eruptions still continue up to now along the East Vietnam Fault scarp.

The historical records showed a close relation between earthquakes and volcano eruption. The last eruption of Hon Tro volcano group in 1923 had followed successive earthquakes from 1877.

The 2005 and 2007 Vung Tau earthquake series offshore Southern Central Vietnam had similar expression with the 1877 ones. They are located at about 40 km west from Hon Tro volcano.

The solutions of M5.2 November the 7, 2005 and M5.3 November the 8, 2005 earthquakes show the east-west extension and N-S shortening of the region. It matches well with other structural and tectono-physical study on geodynamic condition of the region of Southern Central Vietnam and offshore.

Combination of the data shows that the East Vietnam Fault Scarp is continuing to act as normal faulting system and may cause significant earthquakes and volcano.

The tectonic activity of Quaternary–Recent of the Southern Central Vietnam shelf zone tends to create tensional fractures of north-south orientation. The Geodynamic status of the region in Quaternary-Recent period is characterized by extensional stress field with maximum E-W extension.

STATISTICAL (ANALOG) MODEL FOR PREDICTION OF ICE EDGE AND HEAVY ICE BOUNDARY IN THE EAST SHELF OFFSHORE SAKHALIN ISLAND

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Migration of ice edge in the western Sea of Okhotsk, or, more precise, in the east shelf offshore Sakhalin Island, is complicated and mostly depends on atmospheric processes over the Asia-American sector of the northern hemisphere. These conditions, in turn, define winds over the Sea of Okhotsk and intensity of ice formation and drift.

The forecast model is based on the analog method; physical and statistical approaches are synthesized in the same algorithm. The forecast algorithm includes a number of sequential transformations and information selection steps, composition of forecast operator, and the forecast itself. As a result, the task-oriented set of parameters is selected, with similar processes analyzed. Forecast skill is estimated for the predictor fields, with the field ranking based on the values of prognostic values, and the calculation of coefficient of fields' connection of predictors with the field of the predictant at a set shift (early forecasting), etc.

The position of the ice edge and heavy ice boundary have been followed by 12 rays, reflecting the main features of the space-time variability of the given characteristics.

The surface pressure and H_{500} fields have been taken in 32 5°-boxes, located in the Asia-American sector of the north hemisphere.

Using the performance capabilities of this model, a number of experimental calculations have been carried out for the forecast of a set of ice characteristics,

with the 30 days of advance time. The calculations included the forecast of the ice edge position, ice concentration, as well as age and shape of ice formations throughout the Sea of Okhotsk, the position of heavy ice boundary offshore the East Sakhalin and in the south-west part of the Sea of Okhotsk, etc. The forecast period was as follows: from the early December through the end of May; for the heavy ice boundary position forecast was made from the early December through the end of April. This particular period was chosen because the most dynamic processes for all practical purposes occur exactly during this period.

The average accuracy of the forecast for the forecast period of 10-30 days was as follows:

for the ice edge – from 85 to 74%

for the heavy ice boundary – from 79 to 67%;

The minimal values have been observed at the initial stage of the ice season (December-January). At the same time, the values observed are also the least stable ones. From now on, the forecast accuracy is getting better and stabilize, which is apparently related with the increase in the ice inertia.

The forecast method developed is currently used for various regions of the Sea of Okhotsk by many research institutions in the Far East.

WINTER NAVIGATION IN THE SEA OF JAPAN

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The efficiency of operations in Far Eastern seas in winter is largely determined by the knowledge of ice conditions and also by the ability to apply such knowledge adequately. Given that active operations are performed in certain promising and accessible areas or particular shipping routes rather than in the entire basin, it is imperative that those areas be summarized and recommendations provided.

On the basis of the databank that has been maintained since 1956, the paper provides general information on ice conditions in major winter navigation routes (ice phase dates in major and minor seaports, ice route distances, recurrence period of highly compact ice, ice field fragments, large, extensive and gigantic ice fields and ice of more than 30 cm in thickness from the shoreline to ice edge, time parameters – month, 10-day period – marking onset and termination of the ice period) using numerical modeling (a simple viscous ice drift model). Comparison with results of ice drift mathematical modeling has been made and recommendations provided as to how to conduct sea operations.

Navigation and fishing are undertaken in the Sea of Japan all the year round. There are no latent navigation risks in the Peter the Great Bay and offshore the eastern coast of Primorye. This, coupled with the weak ice cover, does not compel navigators to stick to some particular routes, except for approaching the oil base in the Bay of Amur, in which case an ice-breaker is used to clear the way in fast ice. The major and minor ports in the Tatar Strait are situated in more severe climatic conditions, and winter navigation is often impossible there unless powerful ice-breakers are operated. For northern ports in the Sea of Japan, the navigation pattern is determined by wind. In the event of strong and continuous westerly winds, ice becomes less compact in close proximity to the mainland. It is, therefore, reasonable to have the shipping route along the mainland. In the event of north-easterly winds, an ice hole becomes closed near the mainland and ice becomes less compact at the eastern boundary of the Strait; so it is reasonable for the shipping route to be located over there. Otherwise, the shipping route is centrally located, which is governed by the ice pattern observed over many years.

The ports of Vanino, Aleksandrovsk and De-Kastri in the Sea of Japan are most busy. Special emphasis is, therefore, placed on routes to those ports.

THE ATMOSPHERIC ACTIVITY OVER THE NORTHERN PACIFIC

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Investigation of the atmospheric circulation by way of typification was repeatedly used for different areas of the globe. The given typification is carried out on the basis of 50-year period observations and, as compared with the others, it considers the character of cyclone trajectories and the location of anticyclones. The 6 types are distinguished: North-Western (NW), Okhotsk-Aleutian (OA), Latitudinal-Aleutian (LA), Southern-Latitudinal (SL), Okhotsk-Hawaiian (OH) and Cyclones over the Ocean (Co). The NW type is called so, as the cyclone trajectories are situated in the North-Western Pacific. The OA has two depressions – the Okhotsk Depression and the Aleutian one. Under the LA type, cyclones move along the Aleutian Islands. Under the SL type the cyclone trajectories are located near 40-45° from west to east across the ocean. The OH type has two depressions: the Okhotsk Depression and the Hawaiian one. The Co type is characterized by the presence of mainly cyclonic formations over the water area of the Northern Pacific. He NW type of the atmospheric circulation had the total duration of activity for 213 days in 1982,

and in 1950 – only 10 days, the Co type was observed in 1958 for 201 days, and in 1971-1972 it was not observed at all. Total duration of all types activity for a year, three years, and five years is characterized by cyclic recurrence.

EXTREMELY DANGEROUS WAVE HEIGHT IN THE NORTHERN PACIFIC

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The big waves are often the cause of the vessel and cargo loss in the Northern Pacific. Extremely dangerous wave heights (8 m. and more) always condition negative influence on the success of the trade fishery in the Northern Pacific. For the successful work of the fishing-boats the knowledge is necessary on the distribution and the time of appearance of extremely dangerous wave height in the Northern Pacific. Extremely dangerous wave heights are very seldom (less 1%) observed during the warm season in the Northern Pacific. Extremely dangerous wave heights are observed during the cold seasons, especially from November to February, the maximums occurrence (10-12%) is observed in January and February.

Two zones of the maximum frequency of the extremely dangerous wave height occur in the West and East of the Northern Pacific. Two zones of the maximum frequency of the especially dangerous wave heights are conditioned by two convergence regions of frequent cyclone trajectories in the Northern Pacific. Understanding of distributions and frequency of the extremely dangerous wave height allows us to provide security of fishery ships in the Northern Pacific.

SEASONALITY AND LINKAGES OF CLIMATE VARIATIONS IN THE JAPAN (EAST) SEA AND ADJACENT AREAS

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Variability of water properties in the Japan (East) Sea (JES) on the interannual to semi- centennial time scales is estimated on the base of observation data analyses. Time series of sea water temperature, salinity, and dissolved oxygen profiles, grided daily and monthly SST, ice extent, river

discharge, and meteorological data are analyzed by using different statistical methods such as correlation, cluster, and spectrum analyses. Differences and substantial seasonality of the climatic tendencies in the SST and surface water salinity in various JES areas determined by cluster analyses are manifested. Climate change and oscillations of temperature, salinity, and dissolved oxygen in the intermediate, deep, and bottom water are also examined using new observation data. The statistical links between anomalies of salinity, ice extent in the Tatarskiy Strait area and Amur River Discharge as well as negative relationship between anomalies of surface salinity in the Tatarskiy Strait and Korean Strait areas are revealed.

Change of remote linkages between anomalies in JES SST and climatic indexes from the first to second period of the observational records is estimated and discussed.

VARIABILITY IN THE JAPAN/EAST SEA ON THE INTRA-ANNUAL AND INTERANNUAL TIME SCALES

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Variability in characteristic frequency bands on synoptic to interannual time scales in the Japan/East Sea (JES) is estimated using time series of zonal wind velocity and Wind Stress Curl (WSC) from SERSAT satellite data over central JES, Total Water Transport (TWT) through the central JES area revealed from the Nakhodka - Naoetsu JASC submarine cable data, and Sea Surface High averaged over whole JES (JSSH) from TOPEX/ POSEIDON and ERS-1/2 satellite data for the period 1997-2003. The grided daily SST (JMA) from 1997 to 2007 is also involved into statistical data analyses. The significant oscillations of the WSC, TWT, and JSSH are found in similar frequency bands of marine mesoscale dynamic (40-60, 70-100 days), quasi-semiannual (130-220 days), quasi-annual, and interannual time scales. The semi-annual and annual oscillations of the JSSH are prevailed with 93-40% of variance for this time series. The significant lagged statistical relationships between TWT and WSC / JSSH with high correlation coefficient are revealed for quasi-semiannual and quasi-annual time scales. The relationship between TWT and WSC has inversed lag in comparison with link between TWT and JSSH. The best positive statistical relationship between TWT and JSSH is revealed when TWT is

leading with lag of about 4-5 months. The high positive correlation between TWT and WSC is revealed when WSC is leading with lag of about 6-7 months. The time series of SST anomalies over the submarine cable has similar significant spectral peaks like in WSC and TWT spectrums including peak in meteorological synoptic time scale.

THE PHYSICAL OCEANOGRAPHY, HYDROCARBONS LEVEL, AND FISH CATCHES IN THE IRAQI MARINE WATERS, NORTHWEST ARABIAN GULF

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The physical oceanography, levels of hydrocarbons and total fish catches in the Iraqi marine waters, northwest Arabian Gulf were assessed for the period from March 2004 to July 2005. The air temperature was fluctuated from 15°C in January to 37°C, while water temperature ranged from 13°C in January to 32°C in August. The salinity fluctuated from 23‰ in February to 38‰ in July. The water column was less transparent (88cm) in March and highly transparent in June (275cm).

The highest value of total catch per unit of effort was 39.2 kg/hr in August and the lowest value 14.75 kg/hr in January. The largest value of commercial fish catch was recorded in March (17.25 kg/hr) and smallest value in January (6 kg/hr). The mean annual catch for both total and commercial were 33.5 and 11.5 kg/hr respectively.

The results revealed increase in hydrocarbons in the muscles of fish. The lowest and highest were values recorded during winter and summer respectively of all species. The yellow fin bream *Acanthopagrus latus* formed for highest values (192.39-247.63 µg/gm). The minimum values of total hydrocarbons in gonads were recorded in summer and the maximum values in winter for all species. The highest values (231.65-305.39 µg/gm) were observed in large-toothed flounder *Pseudorhombuss arsius*. Fat were determined in studied fish species, the lowest values recorded during winter (6.7 %, 4.2%, 5.7 % and 4.1 %) respectively and highest values recorded during summer (9.75 %, 7.88 %, 9.5 % and 6.8 %) respectively.

RELATIONSHIP BETWEEN AMUR RIVER RUNOFF AND SURFACE SALINITY IN THE TATAR STRAIT

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The Amur River runs into the Sea of Okhotsk. About 30% of Amur River water penetrates through the Nevelskoy and Tatar Straits to the Japan/East Sea and affects the oceanographic condition there. Seasonal and year-to-year variations of the sea water salinity in the Tatar Strait show the relation to the Amur River discharge anomaly. Two salinity minima in the annual cycle are explained. Wind conditions when the fresh water inflows from the Amurskiy Liman to the Tatar Strait are determined.

INTER-DECADAL VARIATIONS OF TEMPERATURE AND SALINITY STRUCTURES IN THE TSUSHIMA STRAIT

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Recently unfamiliar tropical/subtropical species of marine organisms have been found frequently in the southwestern Japan Sea. Since the Tsushima Strait is the most upstream region of the Tsushima Current, long-term environmental variations in this area are a key for the Japan Sea conditions downstream. In this study, we describe inter-decadal changes of temperature and salinity structures in the Tsushima Strait on the basis of the hydrographic data during the period of 1971-2000.

The sections of temperature difference between 1990s and 1970s show positive values throughout the water column in both eastern and western channels of the strait in winter; the left panel shows the section in February. This indicates that the entire region of the strait was warmer in winter of 1990s. The temperature variation in the strait seems to synchronize with the Pacific inter-decadal oscillations in the North Pacific.

A remarkable feature in the salinity difference sections is the wide area of negative values in the eastern channel; the right panel shows the section in

August. Though the feature is recognizable throughout the year, large negative values appear in summer. The freshening in 1990s in the eastern channel seems to associate with the large discharge of the Changjiang in 1990s.

VARIABILITY OF THE SUMMER MONSOON IN THE FAR EAST DURING LARGE-SCALE WARMING PERIOD

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Variability of location and intensity of the atmospheric Centers of Action, namely, Hawaii Anticyclone, Asian Depression, Far Eastern Summer Depression is studied. Boundaries of the corresponding areas were estimated as 13-35°N, 60-100°E for the Asian Depression, as 40°-55°N, 115°-135°E for the Far Eastern Summer Depression, as 30°-45°N, 185°-235°E for the Hawaii Anticyclone.

Pressure (δPo) and geo-potential (δH_{500}) norm magnitudes were calculated for every Center of Action. To identify intensity of the summer monsoon at the first and second stages, differences between norm magnitudes in the areas of the Far Eastern Summer Depression, Okhotsk Sea, Hawaii Anticyclone, Asian Depression were calculated.

In the period of global warming since 1976 intense pressure growth was found in the Asian Depression and in the Far Eastern Summer Depression. Change in the monsoon regime of Centers of Action in the Asian-Pacific region conditioned variability of such important climatic parameters as precipitations and air temperature. Growth of pressure and shift to the east of the Asian atmospheric Centers of Action caused transport of warm air from the land to the Japan and Okhotsk Seas and weakening influence of wet marine air mass during the period of monsoon circulation (weakening of monsoon).

SEASONAL CHANGES IN THE EAST SAKHALIN CURRENT ESTIMATED FROM CTD DATA

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Examination of oceanographic conditions in the northeastern Sakhalin shelf is interesting from the scientific point of view because of the great influence of Amour River runoff. It is also important due to development of oil and natural gas industry. A number of CTD surveys were carried out in this area. However, seasonal changes of temperature and salinity fields are studied insufficiently, resulting in the lack of understanding of seasonal changes in the East Sakhalin Current (ESC). To investigate these problems, we analyzed CTD data collected at the 6 standard (repeated) oceanographic sections crossing the Sakhalin shelf and slope. Long-term monthly mean temperature and salinity distributions were calculated for June – November. In summer significant salinity difference, of several psu, between the northern and southern parts of the northeastern Sakhalin shelf was found. Low salinity water of 24-28 psu originated from Amour River was found in the area from Elizabeth Cape to Chaivo Bay, while its influence is small southward of 52ºN. Well-developed cold intermediate layer, with the core near the shelf edge, was revealed. Significant changes were found in the fall season. Low salinity water is located near the Sakhalin coast from Elizabeth Cape to Terpenia Cape. This corresponds to the ESC intensification in the fall. This intensification, also found from mooring current and satellite altimetry data, results in the transport of low salinity water to the southwestern part of the Okhotsk Sea and in the destruction of the cold intermediate layer.

MODELING OF THE ICE COVER EVOLUTION IN THE SEA OF JAPAN

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Probabilistic modeling of the ice cover evolution in the Sea of Japan is based on the notion on the interaction of ocean, ice cover, and atmosphere as uniform thermodynamic system.

Objective of this research is the estimation of the possibility of probabilistic forecast by construction and analysis of simple probabilistic forecasting models from the limited number components with the help: 1) algorithms of aprioristic conditional probabilities 2) Markov chains of the first order. 3) the Byes approach.

Method of the Byes tests at forecasts according to 10 random years with the earliness about 6 months has shown enough good results. Thus estimations of Bryer basically changed within 0.75-0.95. The percent of verification often reached 100 % that testifies to success of realization of the given scheme for the

ice cover forecast. The analysis of repeatability of components testifies to steady enough mechanism of the influence of the processes occurring in atmosphere and ocean on the formation of ice conditions.

Considering that the existing long-term forecasts are far from perfect, and probabilistic forecasts practically are absent, it is possible to recommend the offered scheme of the long-term probabilistic forecast of ice characteristics for practical use.

UNIVERSAL ENERGY SPECTRUM OF SMALL-SCALE TURBULENCE DURING RUN-UP AND BREAKING OF INTERNAL WAVES IN THE SHELF ZONE IN THE SEA OF JAPAN

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Possible existence of the universal space energy spectrum $E(k)$ for the small-scale oceanic turbulence was suggested by Monin and Ozmidov [1981]. Using the π-theorem [Barenblatt, 1978], the relation $\overline{\varepsilon_{dis}} = 2\nu\,\overline{(e_{jk}e_{jk})}$ [Landau & Lifshitz, 1988] for the mean kinetic energy dissipation rate per unit mass $\overline{\varepsilon_{dis}}$ (where ν is the kinematic viscosity and e_{jk} is the rate of strain tensor), and the refined Kolmogorov hypothesis [Kolmogorov, 1962], we deduce the universal space energy spectrum $E(k) \sim \alpha \frac{\overline{\varepsilon_{dis}} k^{-3}}{\nu}$ (1), where α is an empirical non-dimensional coefficient and k is the space wave-number. The coefficient $\alpha \cong 1/12$ is accepted, in accordance with the interaction time $\tau_i = \left(k^3 E(k)\right)^{-1/2} \le N^{-1}$ [Monin & Ozmidov, 1881] (where N is buoyancy frequency) and by using the experimental data for the critical values of $\overline{\varepsilon_{dis}}$ [Gibson, 1987; Gregg, 1987] for oceanic turbulence. The obtained coefficient $\alpha \cong 1/12$ is in good agreement with the established closure relation $b_{tur} = \frac{1}{24}\frac{\overline{\varepsilon_{dis}}}{\nu} l^2$ [Simonenko, 2006] for the turbulent kinetic energy per unit mass b_{tur} of the small-scale isotropic homogeneous turbulence of the energy-containing length scale l. The deduced relation for the coefficient of turbulent

(eddy) viscosity $\nu_t = l\sqrt{b_{tur}}$ [Kolmogorov, 1942] is in good agreement with the semi-empirical Prandtl relation for ν_t [Monin a& Yaglom, 1975; Landau & Lifshitz, 1988]. The results of laboratory experiments [Gibson, 1968; Hall & Pao, 1969; Stillinger *et al*., 1983], atmospheric observations [Monin and Ozmidov, 1881], and the estimated spectrums of the high-frequency temperature variations in the oceanic bottom turbulent layer [Pavlova, Liapidevskii, Simonenenko, 2008] support the universality of the space energy spectrum (1) for the small-scale isotropic homogeneous turbulence.

CROSS-SHELF EXCHANGE OF THE SUBSURFACE KUROSHIO WATER IN THE EAST CHINA SEA

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Previous studies have shown that the Kuroshio intermediate water constitutes the major source of nutrients on the East China Sea (ECS) continental shelf, and the shelf break region northeast of Taiwan is the primary location for the exchange of Kuroshio and shelf waters. Upwelling at the shelf break has been observed in both hydrographic survey and satellite remote sensing, but the tempo-spatial variations of this upwelling process as well as its physical mechanism remain unclear. There is also open question on the intrusion path of the upwelled Kuroshio water on the shelf and its relation to the Taiwan Warm Current to the west. To investigate this and other related oceanographic issues, a multi-institutional project has recently been started within the frame of the Major Basic Research Plan of China. The scientific goal and progress of the project are reported here.

THE STATUS OF MARINE ALGAE RESOURCES AT HAIVAN-SONCHA AREA

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Marine algae is one component of marine resources. From marine algae can extract to different compounds such as agar, alginat, carrageenan, biological

compounds. They have been used on fields as following: wearve fabric, refresher, medicine.

Haivan-Soncha area belonged to Thuathien-Hue province that contaians diverse in the marine resources, but the studies on the natural resources of marine algae are inadequate.

The findings in the previous studies showed that at Haivan-Soncha area there were 96 species of marine algae, belonged to four divisions as following: *Cyanophyta, Rhodophyta, Phaeophyta* and *Chlorophyta*. Among of them, seventeen species are economical species, they can be used for food, medicine, manure (genus *Sargassum, Porphyra, Ulva*). The natural rendom (immediatly) of the above genus is 36,5; 10,1 vμ 4,8 F. T.

The geographical distribution of marine algae at Haivan-Soncha area seasonally changes in dry, rainy season and behaviors as the site dependence. This distribution is focusing at dry season and sites number 2, 3, 4 and 5.

Nowday, the natural marine algae resources are not yet exploited but tends to be depleted soon under the unfavourable impacts from natural disturbances and human activities.

DETERMINATION OF DEPTH OF THE UPPER ACTIVE LAYER SEA TEMPERATURE IN THE SOUTH CHINA SEA

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The thermal structure of the ocean is composed of three layers: mixed layer, thermocline and deep water layers. The definitions of these layers are based on temperature profiles. The vertical gradient method is used in this paper for determining subsurface thermal structure of South China Sea. The NODC monthly mean dataset for South China Sea was used for study. Some features of the mixer layer in South China Sea and their change in time are analyzed and discussed.

PATTERNS OF TEMPERATURE ANOMALIES AT THE JAPAN/EAST SEA SURFACE, SIMULATED UNDER THE DIFFERENT KINDS OF WIND FORCING

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Patterns of sea surface temperature (SST) anomalies simulated with the use of an oceanic model (Shapiro, 2000) are studied in the Japan/East Sea (JES). The wind forcing is provided by typical wind patterns obtained from EOF analysis of 1°-gridded 6h NCEP/NCAR dataset. The attention is focused on the impact of wind curl over the JES upon the simulated circulation and SST. The semiannual variability is revealed in wind curl over the JES, with a cyclonic (C) curl being more frequent in winter and late summer and an anticyclonic (AC) curl more frequent in spring and autumn. Model runs are performed under the forcing of a semiannually varying curl (Run 0), or a prevailing C wind curl throughout the year (Run 1) or a frequent AC curl in the warm season (Run 2). EOF analysis is applied to daily SST simulated in Runs 0, 1, and 2. Anomalies are calculated by removing the seasonal signal estimated as a leading EOF mode of the original SST. Three leading modes of SST anomalies simulated in Run 0 correspond to those obtained with 0.25°-gridded daily dataset of Japan Meteorological Agency (JMA). Annual, semiannual, and quasi-biennial time-scales are characteristic of JMA SST. SST anomalies from Run 0 reveal annual and semiannual timescales, with the same timing of extreme anomalies as JMA SST. Anomaly patterns of SST simulated in Runs 1 and 2 differ from those for Run 0 and JMA dataset. In particular, the semiannual variability is very weak in the western JES.

REGIONAL THERMAL CONDITIONS IN THE FAR-EASTERN SEAS AND LARGE-SCALE CLIMATIC VARIABILITY

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The purpose of the study is to estimate the relationship of regional thermal characteristics in the Far-Eastern Seas with large-scale climatic patterns and principal oscillations. The former are retrieved from regional data sets based on historical observations, the latter are represented by Arctic Oscillation (AO), Pacific Decadal Oscillation (PDO), Victoria pattern, Southern Oscillation Index (SOI), West Pacific Index (WPI), etc. Any prominent changes in the North Pacific are reflected in the Seas. On the other hand, the regional processes

should be also taken into account, because they can considerably modify the global impact. The stability of statistical relationship, positive or negative, is analyzed, taking into account hierarchy of variability scales, with an emphasis on the sign change from positive to negative or visa versa. Numerous sub-samples of the original data based on running windows from 1 to 3 decades were examined. Pronounced reorganizations of these relationships, with the accompanied inversion, correspond to the 1976/77 and 1988/89 regime shifts. The steadiest relationships are between WPI and regional thermal characteristics. One of the regional parameters, sea ice extent is the natural filter of high-frequency variability. Phase differences in low-frequency fluctuations of the thermal regime in the Far-Eastern Seas and adjacent areas are discussed.

ICE COVER EVOLUTION IN THE BERING SEA

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Estimation of spatio-temporal variability of ice regime characteristics, ice forecast, and development and use of ice models has the scientific and practical importance. Ice cover evolution is a result of thermal vertical ice growth/melting and/or ice drift. The ice model is developed (Chetyrbotsky, 2006), with the basic assumption that sea ice floes can be considered as an ensemble of interacting particles of different sizes and thickness under the same external conditions. The consideration of the joint thermal and wind atmospheric forcing on ice cover, aggregation, crushing, and ice hummocking is possible within this approach. Open sea ice transformations to fast ices during the autumn ice formation and reverse transformations during spring ice melting are considered in the coastal areas. The ice cover variability of the Bering Sea is studied using the Chetyrbotsky large-scale model of sea ice evolution. Durations of processes of formation, mature conditions, and ice cover destruction are revealed using the software implementation of this model. It is shown that concentration and ice thickness are statistically independent, while there is the statistically significant relationship between concentrations and ice forms. Statistically significant relationship between 2 m air temperature in the Bering Sea in the periods of initial stage of ice growth in autumn and initial stage of ice melting in spring is revealed.

WATER TEMPERATURE CHANGES IN THE NEARSHORE ZONE OF ANIVA BAY FROM MOORING OBSERVATIONS

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Aniva Bay is in the center of attention of many scientists because of condensing gas plant and shipment terminal building in the Prigorodnoe village. On the other hand, Aniva Bay is the fishing area, in particular with high catches of pink salmon. For these reasons, The Sakhalin Research Institute of Fisheries and Oceanography together with the Sakhalin Hydro-meteorological Agency carried out the special field experiment to investigate water temperature and current velocity variations in this Bay in July–October 2003.

Five moorings with the SonTek Argonaut 3D current meters were installed in the nearshore zone in the northern part of the Bay. Water temperature and wind velocity data measured at the Novikovo, Korsakov, and Cape Krilion meteorological stations were analyzed. Sharp fluctuations of water temperature near the coast have an impact on the approach of salmon.

Events of the sharp temperature decrease are revealed in the coastal areas of the Bay which were traced also from satellite data. This phenomenon was not earlier observed.

In June the 2°C decrease of water temperature was observed at every station. However, water temperature at the Monetka and Yunona stations fell below zero, from 6° C to -0.6° C for the Monetka station. Low temperature persisted about 3 days, with mostly northeastern winds during this period. After that water temperature increased above zero.

Similar events occured in July. The significant decrease of water temperature was observed under the forcing of prevailing northeastern winds. However, the decreased water temperature was observed only during one day in July. Abnormal temperature was not detected in August.

The sharp decrease of water temperature, not typical for this season, was also observed in September at the Yunona and Monetka Stations. In contrast to June and July, temperature did not fall below zero, although the change was significant and temperature decreased by 12°C.

Upwelling areas, with rise of deep waters to the surface, are biologically productive zones, therefore research of dynamic processes in the coastal zone has both scientific and practical interest.

IMPACT OF ATMOSPHERIC PROCESSES ON THE SURFACE MIXED LAYER IN THE FAR EASTERN SEAS

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The water circulation and evolution of hydrodynamic structures in the surface mixed layer in the Far Eastern Seas are studied using numerical simulations forced by different types of atmospheric processes. A prognostic model is based on the principles of self-similarity (vertical similarity): temperature, salinity, and density are represented by similar functions of depth, thus establishing the vertical stratification. The model includes bottom topography, realistic coastline, water exchange through the straits (open boundary), β-effect, vertical and horizontal turbulent viscosity. The initial condition is taken from monthly temperature and salinity 10′-gridded climatology from GDEM archive (Generalized Digital Environmental Model). The atmospheric forcing is represented by monthly surface pressure corresponding to certain types of baric systems.

Common feature in the surface mixed layer is a mosaic of the anticyclonic and cyclonic eddies developing as result of turbulent mixing. Distribution of hydrodynamic structures has the strongly pronounced seasonal variability and is affected by atmospheric processes of different types. For example, anticyclonic eddies are most developed in autumn (October-November). This corresponds to the atmospheric forcing by the certain types of synoptic situations, most frequent in autumn.

SPATIAL AND TEMPORAL DISTRIBUTION OF PRIMARY PRODUCTION IN THE SEA OF JAPAN

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We consider spatial and temporal variability of primary production (PP) in the Sea of Japan from 1998 to 2007 using newly obtained and published data. PP was estimated using a satellite PP model. The PP derived from MODIS data

was compared with the PP from our observations in the Sea of Japan. We also used the data for 1998-2002, obtained by Yamada et al. (2005). Estimated PP and PP *in situ* are in good agreement. Estimated PP showed spatial variability. We chose four regions for estimation of annual variability of PP, namely Peter the Great Bay (42-43.4°N, 130.5-133.5°E), the central Japan Basin (42-44°N, 136-138°E), the northern area (40-48°N, 128-140°E), and the southern area (34-40°N, 128-140°E). Estimated PP is highest in the southern area and lowest in the central Japan Basin. Annual primary production was about 231, 244, 224, 243, and 242 g C $m^{-2}year^{-1}$ in 2003 – 2007, respectively. Peaks of primary production appeared twice a year, in spring and fall in the southern area, while a single spring peak was observed in the northern area. However, *in situ* primary production data showed autumnal phytoplankton peak as well. The spring bloom contributed about 31.42% to the annual primary production in the entire Sea of Japan. Comparing PP in 1998-2002 after Yamada K. et al. (2005) and in 2003-2007 from our data, a slight increasing trend is observed for most regions and the entire Sea of Japan. This may be related to the enhanced nutrients and growth of partial pressure of carbon dioxide in the atmosphere.

IMPACT OF THE AMUR RIVER DISCHARGE ON THE SHELF REGIONS OF THE OKHOTSK AND JAPAN SEAS

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The Amur River affects a large portion of the continental shelf in the northwestern Okhotsk Sea and the northern Japan Sea. It annually discharges an average 390 km^3 of fresh water, nutrients, and suspended materials, with the formation of a shallow plume detectable up to 100 km offshore. Discharge varies seasonally, being largest in summer and low in fall to winter. The effects of the Amur River discharge on structure and circulation of the shelf regions are analyzed using satellite data (color, sea surface temperature, and roughness) and hydrographic measurements for 2003-2007. During most of the ice-free season (June-October), the northward current flows from the estuary (Amurskiy Liman) into the Sakhalin Bay of the Okhotsk Sea. The buoyant water forms an anticyclonic bulge at the estuary mouth. The coastal current associated with the Amur River discharge flows northward along the Sakhalin coast. Occasionally strong northerly/northwesterly winds tend to push water back towards the Japan Sea.

SHELF WATER MASS CHARACTERIZATION AND NUTRIENT FLUXES INTO THE EAST CHINA SEA BY RARE EARTH ELEMENT AND OTHER GEOCHEMICAL TRACERS

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The East China Sea (ECS) has a high productivity on the continental shelf, one of the largest in the world. Recently environmental problems and ecosystem deterioration has been reported frequently, probably related to variation in nutrient supply. To understand the relative contribution of the various nutrient sources to the ECS, we address the detailed structure and the mixing ratios of the different water masses. Sampling transects of 44 stations stretched from (32.1-N, 127.5-E) to (28.5-N, 126.9-E) using the T/S *Nagasaki-Maru* from 9 to 15 July 2004. Water samples were collected using NISKIN bottles for dissolved oxygen (DO), salinity, nutrients, and rare earth element determinations.

Four water masses in the study area were characterized by the T-S diagram: Chang Jiang Diluted Water (CDW), Kuroshio Surface Water (KSW), Kuroshio Tropical Water (KTW), and Kuroshio Intermediate Water (KIW). CDW moves towards 31-N and 127.6-E. By using REE patterns and nutrients, nutrient-enriched KIW upwells and flows towards the 100 m depth inner-shelf. The mixing ratio of water masses from the CDW, KIW and KTW calculated by REE concentration at depths of 100 m in the inner shelf showed that the KIW fraction is about 30%~60%.

FORECASTING OF CLIMATE CHANGE INFLUENCE ON ZOOPLANKTON IN THE JAPAN/EAST SEA

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Different aspects of environments have am impact on zooplankton populations in both deep water and shelf areas of the Japan/East Sea. Primary production dependence on water stratification, copepods fecundity dependence on water temperature, wind-induced deep-shelf exchange, and terrestrial fresh water discharge influence on neritic communities are investigated and formalized by statistical methods. The driving mechanisms are considered and

linked with climatic indices. Conceptual model of climate change influence on zooplankton abundance and species structure is developed and tested on the climate shifts in the late 1980s and late 1990s. Empirical multiple correlation model of year-to-year fluctuations of zooplankton abundance and composition is developed on this basis. It includes asynchronous links that allows its use for forecasting the state of zooplankton communities with lead time up to 5 years. The model results could be used for elucidation of environmentally sensitive parameters in ecosystem models.

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